Compliments of the Writer

THE TEACHING OF PHYSIOLOGY IN MEDICAL SCHOOLS

BY

W. T. PORTER, M.D.

ASSOCIATE PROFESSOR OF PHYSIOLOGY IN HARVARD UNIVERSITY

THE TEACHING OF PHYSIOLOGY IN MEDICAL SCHOOLS.[1]

By W. T. PORTER, M.D.,

Associate Professor of Physiology in Harvard University.

In the Harvard Medical School, which may be taken as a fair example of the better schools of medicine, physiology occupies one-fourth of the student's time during one collegiate year of thirty-two weeks. Stated instruction is given during two hundred and twenty hours, and the time spent in home study can hardly be less than five hours a week, or one hundred and sixty hours in the year, making a total of three hundred and eighty hours, or one-quarter of the total number of working hours in the collegiate year, on the basis of eight hours' hard work per day. The instruction consists of lectures (one hundred and eight hours) illustrated by diagrams, lantern-slides, models, specimens, and occasional demonstrations; of laboratory work (sixty-four hours, equal to thirty per cent of the stated instruction, and to seventeen per cent of the total time given by the student); of recitations from text-book or lecture notes (thirty-two hours, equal to fifteen per cent of the stated instruction), and of thesis writing, in which thirty-two men in a class of over two hundred present essays put together by them from reading a moderate number of the researches upon the theme assigned. These essays are read before the class, and the reader may be questioned by any student present; the "discussion" is closed by remarks from the instructors. The instruction described begins with the entrance of the

[1] Presented in part at the meeting of the Society of American Naturalists, December 29, 1898. Originally printed in the Boston Medical and Surgical Journal, December 29, 1898.

student into the school, and is terminated by a written examination of two hours' and an oral examination of six minutes' length.

The physiological lectures in medical schools are commonly given by one man over the whole immense field of physiology. This field is much too large to permit of even superficial personal acquaintance by one man. The instructor must therefore necessarily take the chief part of his lecture from a text-book. To this he adds citations of a few experiments or observations taken at random from the original sources. He has not and cannot have real knowledge as to the present state of special opinion on the majority of the chapters in his subject, because none but a specialist can cope with the constantly rising flood of meritorious research in any one field, — to keep pace with the whole of a science which stretches ample arms over the larger part of human and comparative biology is impossible. A natural science cannot be thoroughly well taught except by those who have themselves made experimental investigations in the special field which they would teach. No one in these days can work profitably in many fields and no one man should attempt to teach them all. A man trained, for example, in the physiology of digestion is likely to have but a relatively feeble grasp on the physiology of the circulation, the nervous system, or the special senses. It follows that most of the instruction in the one-man system does not adequately represent the present state of knowledge. It is behind the times in all except the special field cultivated by the instructor himself. So far as possible, the instruction in each field should be given by the man actively at work therein, but this wise principle of the division of labor is not usually regarded.

Printed notes of the lectures are prepared by the students and sold to the class, and many students take their own notes. Occasionally these are good; such are usually taken by students who could learn without the lectures; but commonly the notes are wretched performances and well-nigh useless. They are far inferior to even a moderately good text-book. Students, as a rule, do not seriously study their notes until just before the examination. Many men are persuaded that the lecturer "follows Foster" or some other text-book and excuse their idleness in the lecture hour

by resolves of industrious reading of the omniscient Foster at some future time.

The lectures last a full hour and are frequently held in a badly lighted, badly ventilated, and overcrowded room. Other lectures are sometimes given in this room the hour before, or the student goes from the vitiated air of one lecture directly to another. Students are not given chairs, but are squeezed onto hard, uncomfortable benches. They have no place on which to lay their note-books, and no opportunity is afforded to write notes after the hour, while the lecture is fresh in the mind.

As a rule, in medical schools many of the lectures in physiology are given before the student has any acquaintance whatever with the anatomy of the structures considered, and still more are heard before the student has any real anatomical knowledge, — that based on actual contact with tissues and not upon a glimpse of a distant prosection or a hasty glance at a diagram. Lectures on the functions of the brain and the spinal cord are often delivered to students who never have so much as seen the brain or cord. Pictures in a text-book supply the place of real knowledge. Much of the student's learning is mock physiology, based on mock anatomy. His ignorance of the structures and real appearance of the parts he studies is exceeded by his ignorance of their chemistry.

Passing now to the demonstrations, we find that in the larger schools they are made before an audience of at least two hundred. Thus the greater number cannot see the demonstration clearly. Indeed, the procedure is usually more or less illusive. Take for example the celebrated demonstration of the mammalian heart in the anæsthetized living dog. The student sees at a considerable distance a small object in confused rapid motion; he hears the rattle of an induction machine; the lecturer cries "On!" and the heart stops; "Off!" and the confused motion recommences. The student is supposed to have seen how the heart beats and to have studied the inhibitory action of the vagus nerve. I cite this demonstration because it is one of the best; of many, still less can be perceived, and many, also, do not show more than a method of taking a graphic record. If the class is divided into small sections the glimpse allowed each man does not suffice for a real grasp of the

details. Very commonly the demonstrations requiring much time are given in a course separate from the lectures. In short, most of the demonstrations as now given are an aid to the memory rather than a means of training in science. The position awarded them by the usual lecturer and by almost every student is one of the evidences of the fundamental pedagogical error which renders most medical teaching of anatomy and physiology so largely futile, namely, the deplorable notion that demonstrations are merely illustrative and the book and the lecture the main force. Never was the pedagogical cart more squarely before the horse. Contact with nature is the essential of all training in biology.

The laboratory work in large schools is given in relatively small sections, and is not co-ordinated with the regular lecture course. The student feels that the experiments are purely secondary. The experiments are imperfectly arranged into groups. They merely illustrate the text-book. In no case do they present a full picture of any field. The time allowed is so short that criticism of results and insistence upon the proper standard of excellence is not attempted.

The writing of theses is useful to the few who write, and in a certain degree stimulating to those who hear. But it cannot be denied that the ordinary thesis sows more error in fifteen minutes than can be dug up in several hours. Theses are not seen by the instructors before they are heard by the class.

The instruction is the same to every student without regard to what his life is to be. Much time is given to matters which have a very remote connection with the future of most students, and which are not better material for training the mind than matter bearing directly on the student's future work. This destroys the interest of many — and an uninterested man cannot be taught.

The results of the present method are to be judged in part by the examination. The Harvard examination is easy, contrasted with the standard of non-professional schools, and measured by that standard the scale of marking is extraordinarily indulgent. Nevertheless the majority of the class fails to reach 65 per cent. The examination for the most part does not deal with real knowledge, but may

be passed successfully by the mere reading of a book, and, in fact, the actual preparation for it is almost entirely the memorizing of the text-book or the lecture notes. Students are often questioned about the heart-sounds. Most of them have never listened to the heart. The common reply is the quotation of an unfortunate and misleading sentence in the text-book: "The heart sounds are like the syllables 'lub dupp.'" They are questioned about the motor area of the cortex of the brain. Few of them have ever dissected a brain. Were the class examined as to their real knowledge of things in nature, and not their recollection of a description in a book, a lecture, or a schematic diagram, it is my deliberate judgment, based on the examination of more than one thousand students, that 90 per cent would fail to pass. Those who passed would be clever men who owe little thanks to their stated instruction. The leaders in medicine educate themselves in spite of the regular routine.

The results of the present method are further to be judged by the opinion of well-balanced successful men as to the value of the training in the practice of medicine. It is a significant fact that the regard of such men for the physiology taught in the schools is diminishing, whereas it follows logically from the construction of medical science that it should steadily increase, for physiology is the rock upon which rational medicine is built. In truth, scarcely one student in ten gets a sound knowledge of the elements of physiology. By far the greater number enter the physiological course persuaded that natural science can be acquired from books, and leave convinced that a deal of talk and a pennyworth of nature will give one real knowledge of the action of living tissues.

It is important to inquire how this extraordinary system was developed. The reply is that the present method is a survival of mediæval methods; the student of tradition finds a rich field in the history of medical teaching. The teaching of physiology has split off from anatomy; men now living have taught both subjects in the same course of lectures. Descriptive anatomy became the most conspicuous discipline in medicine at a time when the best mental training could be had only from books, from lectures, from abstractions. It was the flowering time of metaphysics, of authority, of the deductive method. The true principle of

approaching nature discovered by the Greeks survived only in a few men of genius — a spark that in our time has been fanned into flame. Joined to the powerful example of the most liberal education of that period was the difficulty of obtaining material for dissection. Stark necessity united with specious theory to fasten upon this most concrete of sciences the methods of the schoolmen, and to this day the bulk of the instruction in anatomy remains didactic and consists of books, diagrams and more or less misleading models. Most men, when asked to describe a bone, visualize — not the bone, but the picture of the bone in "Gray's Anatomy." Dissections are made to illustrate the book. The printed description is learned by rote and the dissection practised too often simply as a manual exercise. The anatomy of the medical college is largely a memory drill — such as belongs pedagogically in the secondary schools. These seventeenth-century notions have been passed on from anatomy to physiology.

Practical work in physiology has also been kept back by the erroneous ideas that the cost of apparatus and other materials is prohibitory, that medical students cannot master the details of exact experimentation, that delicate apparatus cannot be trusted in their hands, and that instruction to the extent required cannot be given to classes of two hundred or more because the course will become too complicated to be carried out.

The chief obstacle which has kept physiology in an ancient and now almost abandoned path is of a different sort; the cost of the new way is within our present means; the experiments done already show that students will do all that may be required of them; and classes of two hundred or more can be carried through extended laboratory courses with perfect administrative ease — in the past two years students of physiology in the Harvard Medical School have done nearly twenty thousand experiments.[1] The source of the lethargy lies deeper. It lies in the public belief that because anatomy was once taught chiefly from books, it should still be so taught; that the functions of living organs can be learned from books with the occasional

[1] Many of these experiments require the use of living tissues; such were performed on frogs only; either the brain was destroyed before the experiment, or the animal anæsthetized with ether.

exhibition of dead organs; that chemistry should continue to be studied in secondary schools without laboratory work, — in brief, that nature can be studied apart from nature. The public has a just contempt for men who profess to have learned disease without practical observation of the sick,— experience is conceded to be necessary here,— but the public is ready to applaud and even to compel by law the study of the same organs in their normal state by reading or hearing a description at second hand of what some third person saw. Students come from the secondary schools filled with these errors. They ask, "Why should I bother with this laborious practical work when I can get it up from the text-book in the month before examination?" The real drags upon progress are the failure of the secondary schools to teach science by scientific methods, and the fatal conservatism that binds teachers of medicine to a past that we should do well to forget. These venerable delusions no longer impede experts in pedagogy, but unfortunately medical teachers — and this is the last and most important reason for the persistence of the present state of medical teaching — for the most part know little of pedagogy and make no effort to comprehend the sad irony of the phrase "Hours devoted to instruction." The devoted hours do not always instruct. Medical teachers fail to see that medical training should be "for power" and only secondarily for information. The power of dealing with nature can no more be learned from books, lectures, and a few more or less effective demonstrations than foot-ball can be learned by reading about the game and occasionally sitting on the fence a hundred feet from the eleven at practice.

If it be replied to these strictures that a system which produces so many able physicians and good citizens cannot be much in need of improvement, I answer that the men of talent veil the defects of the mass. They owe much to themselves; genius will thrive on the intellectual diet that stunts the merely industrious man. The average student does not build upon a sound foundation. He knows little anatomy, less physiology, and still less chemistry, and even his training in practical medicine has to be supplemented where possible by post-graduate work in a hospital. On the whole it may be said that his industry has been largely misdirected. The figure he makes in the world would be

much worse than it now is were it not that the errors of the first half of the medical course are somewhat atoned by the latter half, which is devoted to practical medicine. The student of practical medicine is nowadays frequently in contact with patients. This part of his education, except for a few brilliant pretences, such as the operations done in the "surgical theatre" before large classes, rests upon a much sounder basis than his instruction in physiology and anatomy. Further, the instructors in the great medical schools are for the most part men of learning, force of character, and devotion to public ends; contact with such men gives the student a high standard of achievement. Yet, important as these influences undoubtedly are, they by no means compensate for the lack of thorough grounding in the basal sciences.

The picture I have drawn of the instruction in physiology in medical schools will not be challenged by teachers of that science. The sense that our methods of instruction neither develop nor much inform the mind is general. It is time that discussion of the difficulties and the way to remedy them should also be general. Physiology is the most highly developed rational discipline in medicine, — not a merely descriptive science like anatomy, — and is well adapted to train the mind in scientific procedure, in the setting of problems for research, in the criticism of methods and results, and in the tests which lay bare shallowness, — matters of great moment to men who shall practise an applied experimental science in the midst of quackery, illusion and pretence. Careful inquiry should therefore be made to determine how far defects of instruction can be remedied with the means at our disposal. The problem is, How far can the correct theory be realized in practice? To what extent can medical students of physiology be taught in the manner in which men are trained to be professional physiologists? Evidently physiologists are likely to study their own subject in the most profitable and labor-saving way.

Much can be done to reconcile theory to practice, but not everything. The size of physiology has broken it into specialties. Even professional physiologists can no longer have personal acquaintance with the whole subject or even a relatively large part of it. The truth of this will be obvious

when it is remembered that since January 1, 1894, more than three hundred researches have been published on the physiology of the heart alone. To a considerable degree the physiologist himself must acquire his information from reading the work of others. It would therefore be idle to expect the student of medicine to get a personal experimental knowledge of the whole subject. He has but a year for physiology and must share that time with anatomy. Grave economic laws demand this time shall not be lengthened, and the day of self-support postponed. The time which he now has must be used chiefly for training and not chiefly for the acquisition of facts, as at present, and this training must follow the lines laid down by physiologists for their own development.

The way of the physiologist is not peculiar. The method of getting a real education is the same from the kindergarten to the specialist. The principle is to train "for power," to use President Eliot's phrase, and not primarily for information. Deal so far as possible with the phenomena themselves and not with descriptions of them. Use as the basis of professional instruction the facts and methods which shall be used by the student in earning his living. Teach the elements by practical work. Associate facts which the student can observe for himself with the facts which he cannot observe. Control the progress of the student, remove his difficulties, and stimulate him to collateral reading by personal intercourse in the laboratory, by occasional glimpses of the researches in progress in the laboratory, and by daily conferences or seminaries. Give the student careful descriptions of the method of performing his experiments, but require him to set down the results for himself in a laboratory note-book, which, together with the graphic records of his experiment, is to form a requirement for the Doctorate. Choose one sufficiently limited field in which experimental work shall be thorough and comprehensive, affording a strong grasp of that special subject. Add to this the typical, fundamental experiments in other fields.

When the student has come thus far, let him choose one of the several electives affording advanced training in the physiology of the medical specialities, such as ophthalmology, laryngology, the digestive tract, the nervous system, etc. These courses should be thorough, should contain the

physiology required of the best specialists, and above all should deal with nature directly. For example, in studying the physiology of the stomach, the gastric juice should be taken with the stomach-tube directly from the human subject, and not obtained merely by adding hydrochloric acid to scrapings of the mucous membrane of swine. This special instruction should be directed by distinguished specialists. Thus the student will be brought into contact with that which will interest him most, the everyday methods of the best physicians, and the specialist will keep his own foundations in repair. It is in connection with these courses that didactic lectures should be given. Up to this point in his work, the student is not ripe. Let there be one to four lectures of not more than forty-five minutes, the subject very limited, so that each set shall present all the existing knowledge on the subject. The purpose of these lectures is to show the student the historical development of scientific problems, the nature of scientific evidence, and the canons of criticism that shall help him to sift the wheat from the chaff of controversy. Lectures of this kind cannot profitably be given by men who have not made experimental investigations in the subject of the lecture; so far as practicable they should be given by the specialists who advise the physiological staff concerning the special courses.

Each student should be required to present one written discussion of some very small and sufficiently isolated thesis, giving the work of the original investigators, together with any observations the student has made for himself. The way of dealing with the sources at first hand will thus be learned.

The student's reading should be correlated strictly with his practical work and should be done in the laboratory in connection with that work. It should not be memorizing, as at present, but the study of graphic records, physiological-anatomical preparations, and other physiological material, with the aid of the text-book. The corrections necessary to bring the book up to date and to correlate it with the practical work can be furnished in printed or mimeographed notes.

Such are the lines along which sound theory directs that the teaching of physiology in medical schools should

proceed. With such a training the student can safely find his way through the constantly augmenting horde of facts and draw vicarious profit from those who are face to face with the mysteries of nature. Such instruction meets also the needs of men intending to make a profession of biological sciences other than medicine. It will be observed that the course offers (1) thorough experimental acquaintance with one field, say the physiology of nerve and muscle, giving the point of view, the general physiological method, training in technique, a basis of analogy, adequate knowledge of one living tissue and thus the elements of all; (2) the fundamental elementary experiments in the remaining fields; with the key which the first course gives, these will unlock much; (3) thorough experimental acquaintance with one special subject; (4) various complementary gains, of which may be mentioned experience in reaching the original sources and in marshalling facts, a certain degree of skill in the methods used by practitioners, direct correlation between physiology and practical medicine. Much might be said of the value of this group, particularly of the correlation just mentioned, but we must hasten on to the demonstration of how these ends are to be attained practically.

The first problem to be solved in planning instruction is whether the student's time is to be given wholly or only in part to the subject taught. Men in training for professional physiology commonly concentrate their energies for a sufficient period on this one subject; and this is regarded as the most economical way of mastering any science, for the ground gained by one day's work is still fresh in the mind when the next day's work begins, and continuity of thought is not disturbed. The plea that the instruction in one subject should be broken by the injection of other subjects in order that the instruction in each may have "time to sink in" need not be entertained; experience shows that much of it sinks in so far that it cannot be got up again without the loss of valuable energy. A more serious objection is that the method of continuous application is highly fruitful in the case of men of exceptional powers, who are keen in spite of protracted effort, but is wasteful for the average brain, which is fatigued and unreceptive after some hours of unremitting labor. The truth of this

must be allowed, but the objection does not apply to wide-ranging sciences such as anatomy and physiology, which are not narrow, hedged-in areas, but which consist rather of broad and diversified domains composed of many contiguous fields, the varied nature of which is a perpetual refreshment. In practice the student of anatomy may divide his time between general anatomy, descriptive human anatomy, histology and embryology, all of which are now taught in the medical curriculum, and the student of physiology may pass from general and special physiology to physiological chemistry, thus resting the mind without interrupting the continuity of effort essential to instruction that must be both rich and frugal.

I would propose, then, that the first year in medical schools be divided equally between anatomy and physiology, the first four months being given to general anatomy, descriptive human anatomy, histology and embryology; the second four to physiology and physiological chemistry, studies which cannot be pursued without a knowledge of anatomy.

In accordance with the principles already outlined, the instruction in physiology should be divided into three parts. Part I, of five weeks' duration, should consist of a thorough drill in the physiology of nerve and muscle, the hours from 9 to 11 being devoted to experiments, the hour from 11 to 12 to study of materia physiologica (physiological preparations, graphic records, etc.), and the time from 12 to 12.45 to a conference or seminary, which should be part lecture, part recitation. In the conference the bearing of the experimental work just done should be developed by systematic progressive questioning accompanied by running comments, to clear up any possible fog. A brief account of other experiments which add to the truth established by those which the student has done for himself, but which are too complex or too protracted to lie within the student's powers, should be brought in here.

Part II, of seven weeks' duration, should comprise carefully-arranged fundamental experiments giving in turn the elements of each field in physiology except that of nerve and muscle, which has just been studied. As before, the whole class works from 9 to 11 upon experiments, from 11 to 12 studies all possible means of illustrating the sub-

ject of the day, and from 12 to 12.45 attends the conference or seminary. In the forty-two days covering this part of the course instructors who find the mixture of lecture and Socratic method unsympathetic may abandon their questioning and fill the time with their own remarks; even such instruction would be far more fruitful than the present lectures, for the student would have had experience in anatomy and would be well grounded in experimental physiology, through his work on nerve and muscle, before the talk began; but the seminary is much more effective than the lecture.

In Part III, covering the remaining four weeks of the term, the instruction is divided into special courses on the physiology of the eye, ear, larynx, digestion, the spinal cord, the innervation of the heart, etc. Each course should consist of experimental work from 9 to 11, the study of preparations and other aids from 11 to 12, and a conference from 12 to 12.45. Each course should be long enough to include all the practicable experiments that should find a place in a systematic, thorough study of the subject. The number of such experiments, and hence the length of the special courses, will naturally be very different in the various instances; thus experimental physiology of the eye will occupy more time than the physiology of the larynx. As many courses should be given at one time as there are instructors in the department. The student may elect the subjects that most interest him, but must choose a sufficient number to occupy him during the entire four weeks of instruction.

The afternoons of the days on which physiology is taught are devoted to physiological chemistry.

After this brief yet comprehensive glance at the scheme of instruction, let us consider the question of ways and means. Let us suppose that the number of students in physiology is two hundred. Experience at Harvard shows that it is of advantage to have the men work in pairs; indeed, many of the experiments in physiology cannot be done by one man alone, because the necessary manipulations require an additional pair of hands. Thus one hundred sets of each apparatus must be provided for Parts I and II of the above course, in which the students all do the same work at the same time. In the elective subjects the

number of sets is much less, first, because the number of students in any one subject is relatively small, and, secondly, because the character of the work permits a method of rotation to be applied. Expensive apparatus, as the ophthalmoscope or the perimeter, can be provided in sets of four, and the section divided in such a way that while four pairs of men work with the ophthalmoscopes four others can work with the perimeters, and so on. Much of the apparatus for the special courses is that in use by physicians in everyday practice, and may be obtained in small quantities from the manufacturers for little or nothing, as the advertisement of their product by its selection to serve as a model in the university is a valuable consideration. The cost of the remaining apparatus for two hundred students should be fully covered by fifty dollars [1] for each pair of students, or five thousand dollars for two hundred students. Much of this apparatus is permanent, some will last for twenty years or more without renewal, and some is likely to require frequent renewal. If it be assumed that the entire plant must be replaced every ten years, surely a liberal estimate, the entire cost of apparatus, including simple interest at four per cent on the original investment of five thousand dollars, would be met by setting aside three dollars a year from the fees of each student — surely a sum within the reach of any large medical school. It is assumed that one piece of each kind of apparatus shall be made by the laboratory mechanic, and bids for a hundred duplicates taken in the open market.

The floor-space required for two hundred students working at the same time is three thousand square feet. It would be of advantage to have this space divided into five adjoining rooms, each accommodating twenty pairs of students under a separate instructor, who shall supervise the work and conduct the conference, rotating in these duties with the professors and other instructors, so that all students shall have in turn the special advantages attaching to the personality of each instructor. The desks and other necessary fittings are simple, and are certainly not more expensive than those now placed in chemical laboratories.

[1] These estimates are based on sums actually paid for the apparatus now in use by students in the Laboratory of Physiology in the Harvard Medical School.

The number of instructors for one hundred pairs of men in a thoroughly systematic course need not be more than five. Experience shows that students prefer to work for themselves largely; they rely upon the printed directions, and need only an occasional hint from the instructors. The ranks of the corps of instruction can be filled by young physiologists. This method was introduced in the Harvard Medical School two years ago, at the suggestion of the present writer, and bids fair to be as successful there as it has proved in other institutions. In return for the time given to instruction, these men receive first of all the privilege of instructing. Well-conducted laboratory classes afford extensive practice in teaching, and at the same time the great number of experiments inevitably and almost insensibly imparts a varied knowledge of the fundamental phenomena of the science; further, these instructors are provided free of cost with the means of research; and at least half their time may be given to investigation; finally, even the instructors of the lowest grade receive a sum of money, which, if not sufficient to keep the wolf from the door, is at least enough for a bare subsistence during the collegiate year. That able specialists would be willing to advise, and even to direct, the special courses in practical subjects does not admit of doubt; they would save time thereby, for these same specialists are obliged to instruct these same students in ophthalmology, laryngology, and the like, in the third or fourth year of medical study, and, as might be expected, the students have long before that time forgotten the facts which they memorized from the text-book shortly before the examination in physiology, and must therefore reconstruct, at the expense of the specialist, the foundation of sand upon which his teaching is to rest. Besides the teaching staff, the whole time of a laboratory man-servant and a scrub-woman, and a part of the time of a competent mechanic, will be required.

Instructors saturated with the *ancien régime*, on reading these proposals will exclaim, "Why! you have made the lectures merely explanatory of the experiments." Precisely, that is the chief excellence of this plan of instruction. They will say, too, that some chapters of physiology are based on experiments too difficult and time-consuming for student instruction and which, therefore, will not fall within the

plan ; of this sort is the complicated balance which is struck between the income and the outgo of the body for the purpose of studying the fate of the starches, fats, and other constituents of the food. The reply is that in these instances the methods pursued by the original investigator, his results, and his conclusions are to be placed before the student during the hours provided for the study of physiological material, and then made the subject of a conference, where the view formed by the student from the study of the original source can be corrected, if necessary, by the view which the professor has himself formed exactly in the same way; the meat on which professors are nourished is just the diet for students — it only need be put where they can get it. But subjects of the nature just discussed develop little " power " and should be allowed no more time than is sufficient to give the point of view, the method, the more fundamental results, and the places where additional information may be found. Finally, we cannot expect to escape the phrase watering-pot, as Bismarck called it. We shall have urged against us certain sanctified expressions, such as the accumulated experience of centuries. Let us answer that the system by which we now teach anatomy and physiology began as a makeshift and has become a dogma. It is sanctified by some centuries of repetition, not of experience, for systematic experiments in medical pedagogy have rarely been made; the oracles have been severe with those who meddled with the tripod.

The force now making for reform is irresistible. It is nothing less than the conviction that the mass of knowledge in every department of medicine is grown so huge as to overwhelm both professor and student. The only refuge lies in a thorough mastery of the scientific method. The medical student must acquire power rather than information. Only thus will he be able hold a steady course through the baffling winds and cross currents of a veritable sea of knowledge.